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Research & Development

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IR ID

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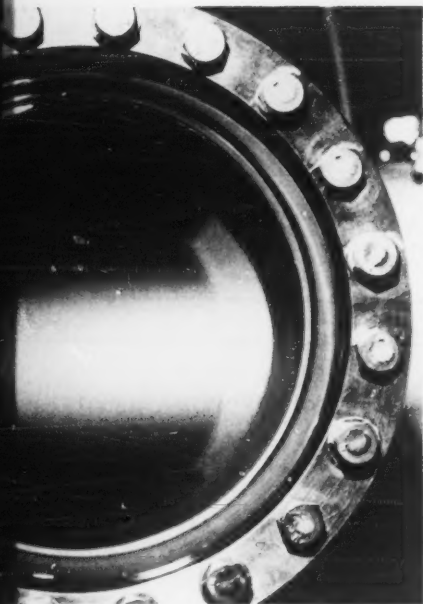
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Now in its 28th year, the R&D 100 Awards program recognizes the 100 most significant new technical products of the past year. See story on page 46. (For a list of winning organizations, see page 49.) Photograph by Paul Ambrose for Catalytica Inc.



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Steel skins, dynamic isolators, and a honeycomb core make this table lighter and more stable than traditional granite, while still providing the static and dynamic rigidity necessary to isolate laser and electro-optic experiments from vibrations.

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DON'T FORGET ...

... to fill out the annual R&D Salary Survey (p. 139). Remember, the more responses we get, the better the data. And the better the data, the easier it will be for you to argue for your next raise. Thank you. —The Editors

IR ID

Europe pushes R&D in electronics

EUROPEAN COMPANIES are concentrating their R&D efforts in developing computers, telecommunications, and electronics, says Jack Blackburn, a London-based representative for the U.S. Dept. of Commerce.

European researchers believe that they must achieve parity in these industries with the U.S. and Japan to compete effectively in all other technological areas, Blackburn says.

The most important trends in the European computer field are the continued use of personal computers, the use of networked systems, and the increased demand for supercomputers, says Blackburn.

About 90% of the supercomputers in Europe are U.S.-made, with the remainder coming from Japan. However, European companies are developing large parallel systems, such as Group Bull's ISIS project, Edinburgh (UK) Concurrent Supercomputer Cen-

ter's 1,000 transputer system, and Esprit's (European Strategic Program for R&D in Information Technology) Genesis project.

European researchers believe that massively parallel systems will be more cost-effective than the current vector systems from IBM, Cray, and Fujitsu. They also believe that the inherent programming problems of massively parallel systems can be solved.

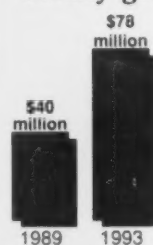
In contrast, IBM, Cray, and Fujitsu are continuing to develop high-speed multiple processor supercomputers, such as Cray's gallium arsenide systems. U.S. research on massively parallel computer architectures is limited to very specific applications.

For now, demand is expected to continue for IBM and Cray supercomputers. These systems currently have 500 times more memory and 70 times more power than supercomputers had 10 years ago.

—Tim Studt

BUSINESS

Steady growth in LIMS



Laboratory information management systems (LIMS) are forecast to grow more than 14% annually to \$78 million in 1993, according to a study by Strategic Directions Intl., a

Los Angeles-based market research firm.

Large computer-based LIMS are more complex and expensive than smaller networked systems but offer large storage capacities and ease of access.

Almost half of LIMS are used in R&D and more than 30% are used in organic chemistry and pharmaceutical areas.

U.S. should rethink use of defense R&D, says economist

DEFENSE R&D FUNDS can and should be used to promote civilian technology," says Robert Cohen, a visiting scholar at the Washington, DC-based Economic Policy Institute.

"Defense R&D is the largest single source of U.S. R&D funds and in spite of cuts in the military budget, it is likely to remain so for the foreseeable future," Cohen says.

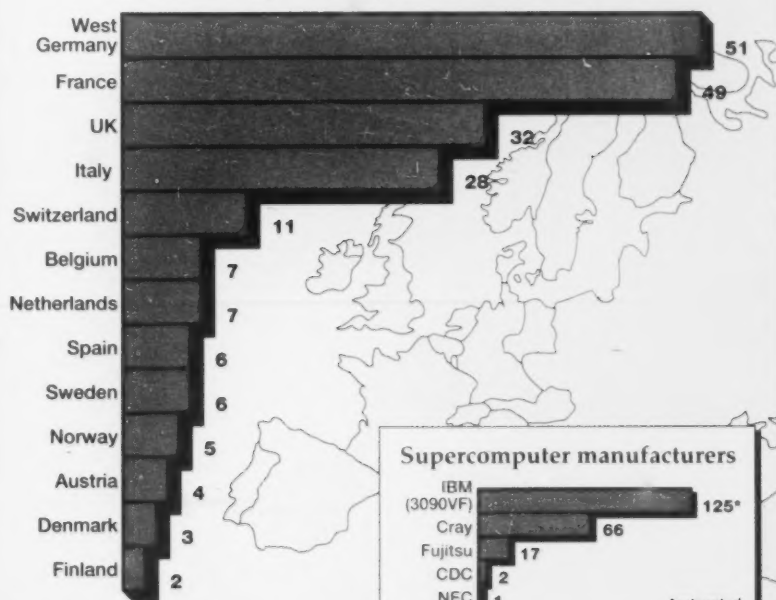
Unfortunately, very little of the technology that comes out of this effort currently is transferred to the civilian economy.

Civilian application of defense R&D is less prevalent than it was 30 years ago, when the current defense R&D structure was established, says Cohen.

The Defense Advanced Research Projects Agency (DARPA) has shown that defense R&D can be used effectively to investigate broad new technologies for use in both military and industrial applications. However, DARPA's budget is less than 3% of the total defense R&D budget.

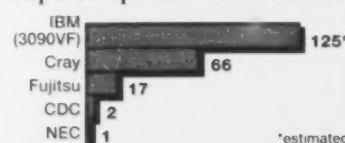
"National security involves economics, the environment, and the education of a technologically sophisticated workforce, as well as adequate

Supercomputers support European R&D



Source: U.S. Office of Naval Research

Supercomputer manufacturers



*estimated

The European supercomputers shown are in government and industrial research labs. Minisupercomputers and computers in sensitive military installations are not included.

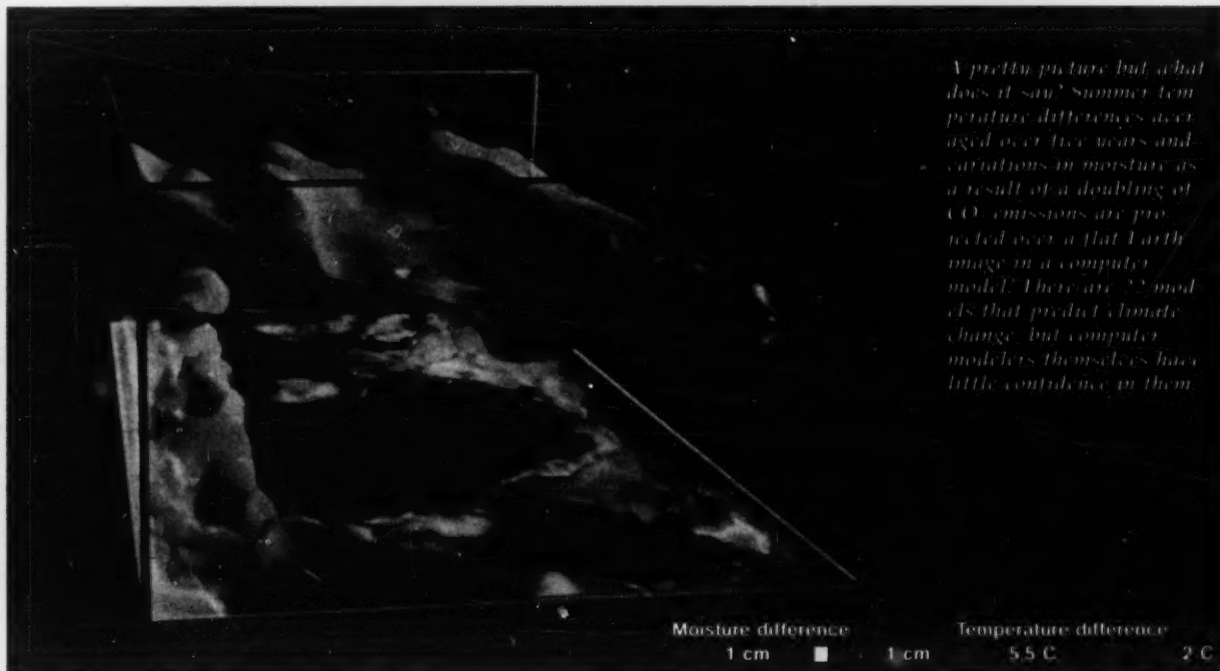


Photo: U.S. National Center for Atmospheric Research/National Science Foundation

ENVIRONMENT

Models cloud climate research

SCIENTISTS trying to assess the effects of global warming are missing a key weapon in their arsenal, accurate computer models.

Without reliable computer models to simulate the effects of such things as increased CO₂ in the atmosphere, many scientists believe clean air legislation will have to be formulated without a key scientific component. Other scientists say the models really are a nonissue because what really is missing is a good theory on atmospheric dynamics.

Scientists have devised 22 models for climate change. Many of them have been developed with specific geographical regions, such as Europe, Canada, or Australia, in mind. When the various models are run in comparison to each other, the result is confusion.

"Some of the models give two to

three times the warming for the same region, and some give cooling," says Lawrence Gates, a climatologist who is leading an international model comparison program based at Lawrence Livermore (CA) National Laboratory. "Some give more rain; some give less rain."

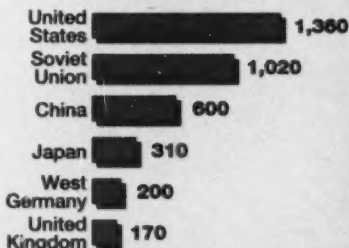
The result has been that the modelers have little confidence in the products of their own work.

"The general consensus of modelers worldwide is that the models are not reliable tools for predicting future climate," says Robert Cess, a professor of atmospheric sciences at State Univ. of New York, Stony Brook.

The problem with the models is that they are too simple to be able to simulate much of the dynamics of Earth's atmosphere. Today's computer models do not effectively handle the impact of the oceans or clouds, nor can

The largest CO₂ emitters

Millions of metric tons*



*Projected emissions for 1990
Source: Draft report of the Energy & Industry Subgroup of the Intergovernmental Panel on Climate Change

The world's largest carbon dioxide emitters are the world's industrial leaders. This means enforcement of a clean air policy could have a big impact on the economies of the U.S. and Soviet Union.

they reliably predict amounts of rainfall or understand the chaotic nature of weather systems. All of these are important components in terms of how Earth responds to pollution.

The models show general global trends, modelers say, but their resolution of 500 km² make it prohibitive for the models to agree on critical regional variations. Many intermodel test projects, like the one Gates heads, are being undertaken. Researchers with these programs are running the models on the same computers for the same periods of time to sort out the good and the bad of each model.

"Eventually the models will converge as we learn more about how the atmosphere works," says Warren Washington, director of the Climate & Global Dynamics Div. at the National Center for Atmospheric Research, Boulder, CO. But, he adds, that could be a never-ending project.

Most scientists agree that Earth is experiencing a general warming trend that is a product of the greenhouse effect. In the policymakers' summary of an Intergovernmental Panel on Climate Change, this worldwide group of climate researchers say global mean temperature will increase 1 C by 2025 and 3 C by the end of the next century if we continue to pump CO₂ into the atmosphere.

But other researchers still are waiting for observational evidence of global warming. Richard Lindzen, a professor of meteorology at Massachusetts Institute of Technology, Cambridge, says the global mean temperature has risen only 0.5 degrees, when it should have risen by 2 degrees, due to CO₂. What this means to Lindzen is clear.

"What is needed first of all is work on theory," Lindzen says. "Where is the theory in all of this?"

However, the more prevalent view is that the jury might still be out, but the time to act is now.

"While it is too close to call [if warming is occurring because of the greenhouse effect,] the numerical models suggest that is the way it will go," says David Erickson, a numerical researcher at Scripps Institution of Oceanography, La Jolla, CA. "Policy action should be taken before the experiment is irreversible."

—Skip Derra

Researcher finds cure for curing agent toxicity

George Dorsey, a scientist at Oak Ridge (TN) National Laboratory (ORNL) adjusts the flow of a reagent during the preparation of a new curing compound for polyurethane and epoxy resins. The resins are used as adhesives, coatings, encapsulants, binders, and filament windings.

The new curing agent does not appear to have the health effects associated with the widely used methylene dianiline (MDA), but it does provide viscosity and mechanical properties similar to MDA. Researchers now are trying to improve the modulus strength of the end product made with the new curing agent.

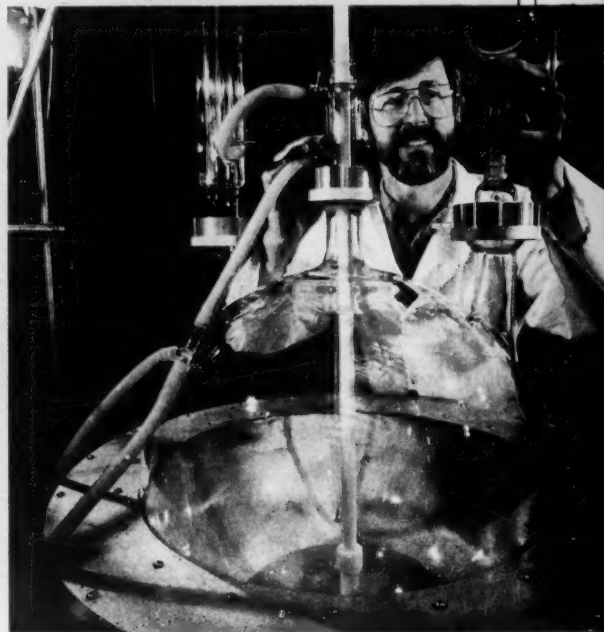


Photo: Bill Norris, ORNL

INSTRUMENTATION

New instruments help unlock clues to star formation

PLANETARY SCIENTISTS, armed with a bevy of new instruments, are taking aim at unlocking the secrets of the stars.

The researchers, from Univ. of Chicago and Washington Univ., St. Louis, are using new microanalytical techniques, including ion microprobe mass spectroscopy, to detect minute levels of materials that literally are out of this world. What the scientists have detected are three compounds—types of silicon carbide, diamond, and graphite—that they say formed outside of the solar system.

"We have found little pieces of material [in meteorites] that actually formed before the solar system formed," says Ernst Zinner, a professor of physics at Washington Univ. "The material comes from other stars."

Zinner says this supports current theory that not all of the elements that make up meteorites are vaporized into huge homogeneous mixtures before solidification. Remnants of meteorites' travels are intact, and they hold clues as to the formation of stars other than the sun.

Zinner says the measurements are

made possible by new instruments that can detect very low isotopic composition levels of grains in meteorites. He adds that now that the researchers have detected the presence of the exotic materials, they want to determine if the materials reside in specific areas or are spread evenly throughout meteorites.

The researchers are testing a new method to aid this effort: it measures materials in situ, without destroying the meteorite. □

SPACE

Ulysses spacecraft will provide unique view of the Sun

IN HOMER'S epic poem, Ulysses' return home from the siege of Troy was held up for a long time by unexpected delays. His modern namesake, the Ulysses spacecraft, which will study the sun, has faced a similar fate.

Don Meyer, an assistant project manager for NASA's Jet Propulsion Laboratory, Pasadena, CA, says while the spacecraft has been delayed from an original 1983 launch date, it now is receiving preferential treatment by NASA. Meyer is optimistic that all will go well with the scheduled October launch of Ulysses from the shuttle Discovery.

"We're looking at it positively,"

Fraud in the lab needs policing, say researchers

CURRENT regulations and checking systems are not sufficient to prevent fraud in industrial research, say 70% of researchers responding to a poll in the May issue of *R&D Magazine*.

More than half (56%) of the 99 respondents say they have witnessed or have knowledge of instances where data or research were changed, "fudged," or otherwise altered to produce more favorable results.

Fully 42% say they feel increased pressure to produce research results that support predetermined outcomes.

Here's what researchers say about scientific fraud. (Due to the topic's sensitive nature, names are omitted.)

I AM A RESEARCH chemist, two years out of college (BS level). Research fraud begins at the college level.

My senior physical chemistry laboratory was set up with 10 experiments. Groups of students rotated among these, theoretically doing a different experiment each week. After the third week of each quarter, having done experiments A, B, and C, no one did any more actual work. Instead, you went in and faked the work for two hours, then came out and provided your data from A, B, and C to

OPINION POLL

someone else and got their data for whichever experiment you were supposed to have done. Even if you tried to do your own work, it was almost impossible because the experiments usually required the work of two people, and honest lab partners were few.

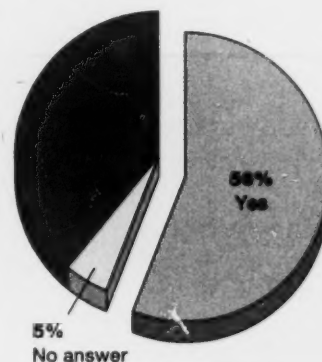
I am currently happily pursuing a master's degree in a nonscience field.

THE GREATEST pressure for fraud seems to be with research project managers changing the results of experimental lab work without the knowledge of the bench chemist who performed the work. This is done to save a manager's pet project, to gain financing, or to save face that was lost on an oversold concept.

I WORK IN AN independent nonprofit biomedical lab, and here integrity and honesty are what it's about. The quality of our research is what keeps grant money coming in.

THE CONCEPT OF (more) regulations is revolting. "Checking systems" are nebulous concepts. Regardless of the magnitude or stringency of any "regulations" or "systems," they will always fall short of stopping anyone who is determined to perpetrate a fraudulent result.

Witnessed fraud

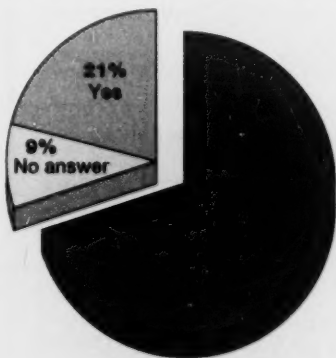


Have you ever witnessed or have you ever had knowledge of any instances where data or research results were changed, "fudged," or otherwise altered to produce more favorable results?

[I WITNESSED] a project manager select only "good" (but legitimate) data to report. "Bad" data were labeled "inaccurate" and not distributed. I think he was only trying to put his program in the best possible light.

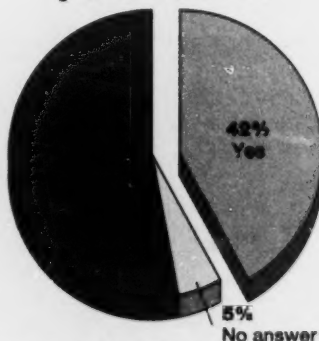
We perform industrial research—about 30% pure research that can be published and 70% product research that is proprietary. There is no cross check or peer review in the 70% product R&D.

Current checking systems



Are current regulations and checking systems sufficient to prevent fraud in industrial research?

Pressure to meet preset outcomes



Do you, in your work, feel increased pressure to produce research results that support predetermined outcomes?

FUDGING DATA is hardly new to science. There is evidence that Isaac Newton "cleaned up" some of his optics data when it did not fit his theories. That alteration of data and suppression of alternative theories held back the development of optics. Present-day hazards of fraud are far more specialized, but in many ways, more dangerous.

Decisions concerning the future of such fields as genetic engineering and the use of new materials and fuels will be made by a population that is largely scientifically illiterate.

If we, as scientists, don't start acting responsibly and fairly in [dealing with fraud, this task] might be taken out of our hands by a distrustful public. Imagine, for example, [the situation if] a company had to have an indepen-

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dent laboratory verify all aspects of the development of a new product before it was allowed to manufacture that product.

I WORK FOR a very large and prestigious pharmaceutical company. I have seen it change from a company that prided itself on doing good science and producing quality products to a company that prides itself on being number one. This change in "philosophy" has created an aggressive and competitive spirit among the employees, which has encouraged misconduct.

THE MATTER OF dishonesty, cheating regarding credit to the generator of ideas in both patents and product approaches, and outright fraud is much worse than most people imagine.

There is the pressure to publish. In industry, the perceived need is to look out for number one. In academe, "peer review" favors those who have gotten a start. Honest judgments are colored by the politics of "I'll take care of you, and you take care of me." In

government research grant applications, there is gross dishonesty in many instances, from flaky data to using data from outside the project to flesh out the "accomplishments."

In graduate school, my professor gave me a thesis to review. The experimental approach was faulty and badly designed, invalidating the data. He agreed on that point, but passed it. "The senior professor in the department designed the approach," he said. "I cannot say that it is not valid."

*I wouldn't do it,
and it cost me
promotions and
plenty of heartache.*

RESEARCH FRAUD is as rife as the biased product claims heard on television.

A famous example is that perpetrated by the head of the EPA some years ago who omitted lab results that

tended to show no deleterious effects of auto exhaust on human respiratory systems.

The present hassle about the greenhouse effect is another example. . . . Not so long ago there was the fluoride swindle . . . [Now there's the] oat bran scam . . .

Research fraud is not confined to fudging results. It is just as dishonest to base conclusions on limited tests, to cast out conflicting data, or to incorporate skillfully worded disclaimers to trap the unwary, while leaving adequate legal outs.

A PRACTICE, which I find to be somewhat less than honorable, requires that we test production samples, determine their performance, then retest those samples after repainting, repolishing, or retrofitting in order to "bump the numbers" into a more favorable light.

I have complained to my superiors that the results are not representative of the end product. . . . The "enhancement" procedures are not limited to in-house tests either. Most [customers] insist on independent test reports. I was angered to learn recently that once the test reports leave our laboratory, sales and marketing



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OPINION POLL

personnel add their own "embellishments." Test data, test configurations, even the components themselves are misrepresented at will to produce a "juicier" enticement for the customer-to-be.

Approaching my supervisor has only gotten me cool defensive rationalizations that "this is the way others in our industry do it." Further attempts to squawk to the higher-ups will certainly result in my being asked to find another job [as happened with a colleague with impeccable credentials].

ONCE, WHILE WORKING for a private research institute, I observed data that had been "fudged." I had been assigned the task of reproducing some materials for a company that had paid for research and development of this material. When I was unable to reproduce these materials, I went back to the laboratory record book and found that the original raw data and proper calculations would not produce the physical properties of the materials originally reported.

Another time, I overheard a colleague suggest that test data from a particular specimen be thrown away because it did not compare favorably with the other test data.

I don't have any concrete suggestions on how to prevent cheating other than [to] eliminate the incentive to cheat. If there were other criteria for advancement and compensation of scientists, other than published papers, then perhaps cheating in research could be eliminated.

RESEARCH FRAUD, like any other kind of fraud, was, is, and will be. Only Asimov robots will not lie (perhaps!).

THE EVIL, sinful nature of man becomes apparent even amongst the high priests of scientific research. Even a PhD does not make a thief an honest man. Many up-and-coming scientists push their way up by making data look *much* better than they actually are—standard operating procedure.

CURRENT REGULATIONS and checking systems are adequate. One of the nice things about nature is that the research results obtained by cheating always eventually are discovered.

Greater regulations would stifle research by increasing bureaucracy, but those who cheat still would find a way.

Almost all research is subject to an "expectation bias." If the results of an experiment confirm a hypothesis, they generally are accepted. Unexpected results usually are subjected to a great deal of examination.

To be unbiased, a researcher should spend equal time reinvestigating all experiments for experimental error, not just those that produce unexpected results.

ALTERING DATA in any way is grounds for immediate termination of employment.

HONESTY OFTEN results in the termination of employment in the pharmaceutical industry.

ANY CONCLUSIONS not supported by a thorough statistical treatment are as bad as complete fraud.

ONE DOESN'T have to actually falsify data. One can lie by omission; allow the reader to draw the wrong conclusion. My agency (Federal government) has done the above.

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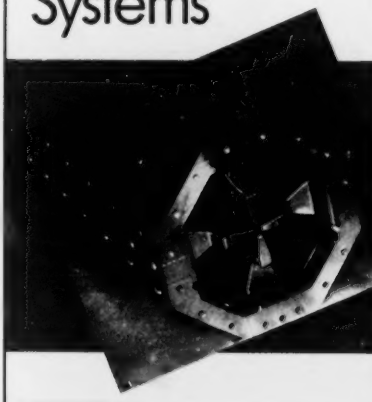
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